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Evaluation of maize fertilizer mixture performance on post harvest soil fertility

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Summary

A field experiment was conducted to study the effect of fertilizer mixture on soil available nutrient content. The experiment was conducted at Maize Research Station, Vagarai, Dindigul district, Tamil Nadu in Randomized Block Design with seven treatments replicated thrice. The treatments included the application of 120 kg urea+ 50 kg DAP –Farmers' practice (T_1), Farmers' practice with Tamil Nadu state Dept. of Agriculture micronutrient mixture @ 25 kg ha^{-1} as straight chemical fertilizers (T_2) as well as EFYM (T_3), recommended dose of fertilizer (T_4), RDF with TNAU -micronutrient mixture @ 12.5 kg ha^{-1} as straight chemical fertilizers (T_5), RDF with TNAU - micronutrient mixture @25 kg ha^{-1} as straight chemical fertilizers (T_6) as well as EFYM (T_7). The availability of macro and micronutrients were recorded at different stages of maize crop growth like knee high stage, tasseling and at harvest stage. The experimental result has revealed that though the availability of nutrients decreased with the advancement of crop growth, application of recommended dose of fertilizer with 25 kg ha^{-1} of TNAU micronutrient mixture as enriched FYM has registered the increased availability of macro and micro nutrients even in post harvest soil.

Key words : Micronutrient mixture, Recommended dose of fertilizer, Enriched farm yard manure

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Introduction

Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat in India. It is cultivated over an area of about 9.4 million hectares with a production of about 24.35 million tonnes and productivity of 2.41 t ha^{-1} of grain in India (Agricultural Statistics at a Glance, 2014). It is a versatile crop and can be grown throughout the country under even diverse environments. Exploitive agriculture involving modern production technology with the introduction of high yielding hybrids coupled with use of high analysis fertilizers leads to deficiency of micronutrients.While micronutrients are required in relatively smaller quantities for plant growth, they are as important as macronutrients. If any element is lacking in the soil or not adequately balanced with other nutrients, growth suppression or even complete inhibition may result (Mengel *et al.*, 2001). Micronutrients are involved in the key physiological processes of photosynthesis and respiration (Marschner, 1995) and their deficiency can impede these vital physiological processes thus limiting yield gain. Fertilizer recommendations by ensuring mixtures of macro and micro nutrients of the test crops help to boost the yield of crops and sustain high crop yields since they become

Table A : Treatment details of the experiment	
T_1	Farmers' practice (Basal application of 50 kg urea and 120 kg DAP ha^{-1} without micronutrient mixture)
T_2	Farmers' practice with micronutrient mixture as straight chemical fertilizer (50 kg urea and 120 kg DAP ha^{-1} + State Dept. Agrl. micronutrient mixture @ 12.5 kg ha^{-1} as straight chemical fertilizer)
T_3	Farmers' practice with micronutrient mixture as EFYM (50 kg urea and 120 kg DAP ha^{-1} + State Dept. Agrl. micronutrient mixture @ 12.5 kg ha^{-1} as enriched farm yard manure)
T_4	RDF
T_5	RDF with TNAU micronutrient mixture @ 25 kg ha^{-1} as straight chemical fertilizer
T_6	RDF with TNAU micronutrient mixture @ 12.5 kg ha^{-1} as enriched farm yard manure
T_7	RDF with TNAU micronutrient mixture @ 25 kg ha^{-1} as enriched farm yard manure

Table B : Details of TNAU micronutrient mixture		
Sr. No.	TNAU micronutrient mixtures (kg /100 kg mixture)	
1.	Iron sulphate ($FeSO_4$)	39.5
2.	Manganese sulphate ($MnSO_4$)	8.2
3.	Zinc sulphate ($ZnSO_4$)	23.8
4.	Copper sulphate ($CuSO_4$)	5.2
5.	Borax	11.9
6.	Sodiym molybdate	1
7.	Filler	11.3

'rationalized' doses of fertilizers for crops. The application of FYM will positively interacted with the inorganic fertilizer nutrients which are essentials to produce the organic acid and formation of metal chelates and thus, protecting them from adsorption and fixation in the soil (Lee, 1985). The concept of balanced fertilization paves the way for optimum plant nutrient supply to the full growth potential of crop and takes care of nutrient stress of soil. Hence, the present investigation was performed to evaluate the effect of fertilizer mixtures on soil available nutrient status.

Resource and Research Methods

A field experiment was conducted at Maize Research Station, Vagarai, Dindigul district. The experiment was consisted of seven treatments which replicated thrice in Randomized Block Design. Maize seeds (CO-1 variety) were sown on the side of the ridges by adopting a spacing of 60 x 30 cm at a depth of 5 cm. The recommended dose of fertilizer (RDF) for maize variety was 135:62.5:50N, P_2O_5 and K_2O kg ha^{-1}. Nitrogen was applied in three splits *viz*., 25: 50: 25 per cent as basal, 25 and 45 DAS, respectively. The entire dose of phosphorus was applied basally. The potassium was applied in two equal split doses *viz*., basal and at 45 DAS. The N, P and K fertilizers were applied in the form of urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively.

The micronutrient mixture contained the mixtures of micronutrient fertilizers like iron sulphate, copper sulphate, zinc sulphate, manganese sulphate and sodium molybdate. The micronutrient enriched farm yard manure was made by physical mixing of the micronutrient fertilizer mixture with the organic manure at friable moisture in 1: 10 ratio and incubation for one month and then used for field application. The treatments details and details of TNAU micronutrient mixture are given in Table A and B, respectively. The soil samples were examined for available nutrient content with frequent intervals like knee high stage, tasseling and after harvest.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Initial soil properties :

The soil of the experimental site was sandy clay loam, non-saline and neutral in pH. The organic carbon content of the soil was low (0.32%). The available nutrient status of experimental soil was low in available nitrogen (174.7 kg ha^{-1}), medium in available phosphorus

(19.72kg ha^{-1}) and high in available potassium (780.2 kg ha^{-1}). Regarding micronutrient status of experimental soil was sufficient in available copper (1.46mg kg^{-1}) and manganese (2.67mg kg^{-1}) and deficient in iron (1.92mg kg^{-1}) and zinc (0.29mg kg^{-1}).

Effect of fertilizer mixture application on soil available nutrients :

Soil available nitrogen :

Soil available nitrogen content was estimated at different stages of crop growth like knee high, tasseling and at harvest stage. It ranged between 168.5 and 234.5, 165.1 and 243.8 and 164 and 209.1 kg ha^{-1}, respectively (Table 1). The highest soil available nitrogen content was observed in the application of macronutrient with TNAU micronutrients mixture (T_7) @ 25 kg ha^{-1} as enriched farm yard manure. This was followed by the application of macronutrient with TNAU micronutrients mixture @ 12.5 kg ha^{-1} as enriched farm yard manure (T_6). The reason might be due to the progressive increase in its availability with corresponding increase in the levels of applied NPK mixture. The higher rate of mineralization and release of N from the soil, fertilizers and organics could have contributed to the increase in the available N in the soil. Higher availability could be due to the direct contribution of nitrogen supply through organics as well as increased microbial activity and partial pressure of carbon dioxide in the micronutrient enriched treatment, resulting in an enhanced release of native N sources. Similar findings were reported by Sawargaonkar *et al.*

Table 1 : Effect of fertilizer mixture on soil available N, P and K at different stage of crop growth (kg ha^{-1})

Treatments	Nitrogen			Phosphorus			Potassium		
	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest
T_1	168.5	165.1	164.0	25.39	21.17	19.32	780.2	767.0	745.1
T_2	172.7	166.2	164.5	25.91	22.36	20.35	808.8	783.5	758.4
T_3	183.4	172.4	167.5	29.10	24.78	22.70	818.5	788.9	763.2
T_4	217.1	217.7	185.2	25.15	21.38	20.08	823.8	814.5	811.3
T_5	229.5	223.5	186.2	28.09	24.20	22.67	824.8	821.5	813.3
T_6	232.1	227.1	190.3	29.65	24.78	22.34	833.8	826.7	819.6
T_7	234.5	243.8	209.1	32.11	28.46	25.09	859.4	852.7	840.5
S.E.±	9.6	9.5	3.8	3.48	3.40	2.23	6.4	7.3	9.8
C.D.(P=0.05)	21.1	20.9	8.3	NS	NS	NS	14.0	16.0	21.4

T_1 – Farmers' practice; T_2 – T_1 + Dept. of Agriculture micronutrient mixture @12.5 kg ha^{-1} as straight chemical fertilizer
T_3 - T_1 + Dept. of Agriculture micronutrient mixture@ 12.5 kg ha^{-1} as Enriched FYM ; T_4 – NPK mixture alone
T_5 – NPK + TNAU micronutrient mixture @ 25 kg ha^{-1} as straight chemical fertilizer ;
T_6– NPK + TNAU micronutrient mixture @ 12.5 kg ha^{-1} as Enriched FYM; T_7 – NPK + TNAU micronutrient mixture @ 25 kg ha^{-1} as Enriched FYM
NS= Non-significant

Table 2 : Effect of fertilizer mixture on soil available of Fe, Zn, Cu and Mn at different stage of crop growth (kg ha^{-1})

Treatments	Iron			Zinc			Copper			Manganese		
	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest	Knee high	Tasseling	Harvest
T_1	1.85	1.71	1.32	0.280	0.270	0.240	1.45	1.44	1.43	2.34	2.29	2.14
T_2	2.29	2.22	1.89	0.340	0.330	0.320	1.49	1.48	1.47	3.12	2.76	2.44
T_3	2.58	2.40	2.11	0.420	0.370	0.360	1.57	1.53	1.50	3.65	3.13	3.13
T_4	1.86	1.77	1.28	0.280	0.250	0.240	1.44	1.41	1.41	2.34	2.31	2.13
T_5	2.72	2.39	2.11	0.407	0.400	0.380	1.62	1.54	1.51	3.62	3.13	2.93
T_6	2.78	2.44	2.22	0.374	0.370	0.360	1.53	1.50	1.50	3.74	3.59	3.11
T_7	3.61	3.15	2.87	0.470	0.440	0.429	1.62	1.58	1.54	4.16	3.65	3.25
S.E.±	0.13	0.07	0.07	0.011	0.015	0.009	0.01	0.01	0.01	0.09	0.11	0.04
C.D.(P= 0.05)	0.29	0.14	0.16	0.024	0.033	0.020	0.03	0.02	0.02	0.19	0.25	0.09

T_1 – Farmers' practice; T_2 – T_1 + Dept. of Agriculture micronutrient mixture @12.5 kg ha^{-1} as straight chemical fertilizer;
T_3 - T_1 + Dept. of Agriculture micronutrient mixture@ 12.5 kg ha^{-1} as Enriched FYM ; T_4 – NPK mixture alone;
T_5 – NPK + TNAU micronutrient mixture @ 25 kg ha^{-1} as straight chemical fertilizer ;
T_6– NPK + TNAU micronutrient mixture @ 12.5 kg ha^{-1} as Enriched FYM; T_7 – NPK + TNAU micronutrient mixture @ 25 kg ha^{-1} as Enriched FYM
NS= Non-significant

(2008).A marked decline in the availability of macro and micronutrients in the soil was observed with the advancement of crop growth period might be due to the continuous removal of nutrients by the crop and loses due to fixation and leaching. This result is in line with the findings of Amujoyegbe *et al.* (2007). The application of fertilizer mixtures resulted in higher N availability than control.

Soil available phosphorus :

Available phosphorus content of the experimental soil ranged from 25.39 to 32.11, 21.17to 28.46 and 19.32 to 25.09kg ha^{-1} at knee high, tasseling and at harvest stages, respectively (Table 1). Though the application of macronutrients with TNAU micronutrient mixture @ 25 kg ha^{-1} as EFYM recorded the highest available P content irrespective of the stages of the crop, there was no any significance in the availability of phosphorus which might be due to the interaction effect of micronutrients with phosphorus. With advancement of crop stages the available P content got reduced which might be due to fixation of phosphorus. But in the micronutrient applied treatments, the enrichment of FYM improves the P availability by reducing the P fixation in the soil by the formation of metal chelates (Senthil Kumar *et al.*, 2004). The influence of fertilizer mixture treatments on P availability was also marked in spite of the P dose applied to farmers' practice treatments.

Soil available potassium :

Soil available potassium ranged between 780.2 and 860, 767 and 852.7, 745 and 840 kg ha^{-1}. The highest availability of potassium was observed in the treatment T_7 as well as the lowest in T_1. Invariably in all the treatments the availability of potassium was high since the initial soil has high potassium content.The increased available K might be due to intrinsic properties of soil or either by the application of fertilizers. Even though, the soil has more amount of available K, the macronutrients with micronutrients were applied as priming dose which will enhance the ability of the crop to absorb available K. Soil application of potassium fertilizers helps to maintain sufficient level of K (Sekhon and Singh, 2013).

Soil available micronutrients :

Micronutrients like iron, zinc, manganese and copper were analyzed for availability in soil. Due to application of micronutrient mixture, the availability of micronutrients was estimated for different stages of crop growth. The iron availability after maize harvest ranged between 1.32 to 2.87, zinc 0.240 to 0.429, copper 1.43 to 1.54 and manganese 2.14 to 3.25 (Table 2). Initially the availability of micronutrients increased but with the advancement of crop stages, the availability tend to reduce. The highest availability of micronutrients was recorded in application of macronutrients with micronutrients @ 25 kg ha^{-1} as EFYM (T_7) in all crop growth stages. Conjoint application of organics with inorganic micronutrient fertilizers enhanced the availability of micronutrient cations in the soil. The applied FYM might be positively interacted with the inorganic fertilizer nutrients which are essentials to produce the organic acid and formation of metal chelates and thus protecting them from adsorption and fixation in the soil (Kumar and Yadav, 2003). Barker and Pilbeam (2007) explained that the interactions do not always occur between these elements, however; found that the interaction between Cu and Zn depends on the species-specific nature of plant response to various fertilizers, requirement of plant and the nature of soil and fertilizer.

Conclusion :

The availability of macro and micro nutrients showed a gradual decrease from knee high stage to harvest of the maize variety and recorded higher under the application of recommended dose of fertilizers (NPK) with TNAU micronutrient mixture @ 25 kg ha^{-1} as EFYM compared (T_7) to farmers' practice of the experimental site. The maximum availability of nutrients will enhance the nutrient uptake of the crop which ultimately results in crop yield. Hence, it is concluded that recommended dose of fertilizers with TNAU micronutrient mixture as enriched farm yard manure @ 25 kg ha^{-1} may be recommended for maize to maximize the yield with higher B: C ratio.

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